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Building Cumulative Knowledge through Literature Reviews

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ABSTRACT

Sometimes a literature review returns a wealth of conflicting results that succeed only in clouding our knowledge rather than clarifying it. This is partly because literature is often not cumulative, making it the responsibility of the reader to synthesise knowledge across articles. This synthesis involves a difficult cognitive process, but one that can be supported with modeling techniques. Through a case study the paper reports an unusual application of influence diagrams, and proposes a framework for building cumulative knowledge through literature reviews. The impact of the models on the case study organisation's knowledge and decision making is presented.

Keywords

influence diagrams, knowledge, literature review, structuring complex problems

1.0 INTRODUCTION

Literature reviews are a necessary inclusion for any academic research project, yet the guidelines on writing these suggest that they may very well be a weakly understood, ambiguous and contentious task (Tranfield, Denyer & Smart et al., 2003). As in any decision making activity, what to include/exclude might be more influenced by personal knowledge and bias than a systematic review of what knowledge is available and necessary.

Models can assist researchers in making literature reviews more reliant on good analysis than on luck. Although developed by the Operational Research/Management Science (OR/MS) community to assist decision makers in better understanding problematic situations, the principles of problem structuring (Rosenhead & Mingers, 2001) and influence diagrams (Clemen & Reilly, 2001) can be used to analyse the context and detail of a decision to enable pertinent knowledge to be considered.

The aim of the paper is to show the application of problem structuring and influence diagrams to help researchers understand a very complex situation that was made more confusing by the lack of a consistent message from the literature. We draw a parallel to groups where different people might perceive the situation differently. Problem structuring methods (PSMs) and influence diagrams can help here to identify commonalities and assist group members to work through differences to build a shared view of the issues. In our case the group was a set of research articles and each presented a different perspective of the situation and proposed different models for making sense of it.

The context of our paper is a North African mining company that needed: (a) to identify which activities to outsource to a local economy that does not offer a set of reliable subcontractors; (b) to manage operations during outsourcing whilst maintaining performance. The general message from the most of the literature was: do not outsource. The company was determined: outsourcing is the only option, just help us to understand how it can be done least painfully. Through managing knowledge from the literature, a research team analysed the breadth of literature associated with this topic and developed models which overcame the inconsistent, contradictory messages offered. These models were used by the company's managers during meetings in which decisions were made. The models helped the managers to better understand the drivers and effects of options.

The paper first introduces the principles of structuring decisions when there are multiple sources of conflicting knowledge. This leads to a description of the procedure used to produce the literature review. The case study of using this procedure is followed by reflections on its usefulness for the researchers and the organisation's managers. Implications and conclusions follow.

2.0 STRUCTURING KNOWLEDGE FROM MULTIPLE SOURCES

The term *problem structuring* refers to a variety of activities and actions through which individuals and groups can discover the true essence of a problem

and design potential ways of tackling it. PSMs emerged to address problems that exhibit unusual levels of complexity and uncertainty where individuals' unique perceptions of the causes/consequences of action are key (Rosenhead & Mingers, 2001). Often the reason for this complexity is that the individuals hold different, conflicting knowledge/perspectives of fundamental aspects of the problem and potential solutions.

Models are central to the process of helping make sense of different perceptions. The content of the models emerge from the participants during conversation (either with an interviewer or during a group workshop) or through some other data capturing methods (e.g. email, through electronic brainstorms). The model can first represent all of the individuals' different perceptions. Then individuals can use the model to explore these perceptions and collectively develop a richer understanding of it than any single individual held previously (normally done during some sort of group exercise). The aim is often to build a 'group perspective' of the situation which accommodates enough of the original perspectives that group members are willing to accept it. The role of the model in supporting dialogue and building agreement between group members partly distinguishes PSMs from other modeling techniques. These approaches have previously been discussed in the KM literature e.g. Shaw (2006).

In Decision Analysis, influence diagrams can represent the causal influence between concepts which are central to a decision. When used as a problem structuring method, influence diagrams can represent different individual's perceptions of a situation and the model can support the group in negotiating a shared perspective of that structure (Rosenhead & Mingers, 2001).

In this context, the aim of an influence diagram is to illustrate the relationships between issues which affect an outcome or situation. When drawing an influence diagram, the analyst will first select the key concepts i.e. those that are central to the situation and without which the definition of the problem would be grossly deficient. Then they will explore the nature of the relationships between those concepts – attempting to adequately model the causal influence e.g. 'A' influences 'B'.

In summary, when using influence diagrams as a PSM, their strength is their ability to take a group from extreme confusion and conflict, to a situation in which group members build shared knowledge and agree on the formulation of a problem structure. As we show below, these methods can be adapted to support extremely confusing situations where the multiple, conflicting perspectives of the problem are brought by a collection of research articles.

3.0 STRUCTURING KNOWLEDGE FROM LITERATURE REVIEWS

Problem structuring can assist researchers in their design of a literature review, and in the process of making sense of the literature to generate findings. For the design of the review to uncover the maximum relevant knowledge, researchers can use the modeling approaches to ensure their review will address all pertinent issues associated with the topic of study. In the systematic literature review (SLR) process (Tranfield et al., 2003) groups inform the process by a panel of experts shaping/agreeing the protocol for the review e.g. the keywords to be used and even the articles to be short-listed. The idea of using SLR in management research is a recent development. However, SLR has a prestigious track record in medicine where several independent studies are subjected to meta-statistical analysis. SLRs have only recently been successful in the social sciences, where, as in management studies, the diversity of research methods used prevent meta-statistical analysis. In the social sciences and management research, the strength of SLR is that groups of researchers can collaborate to define the scope of their inquiry in a way that is similar to group processes in organisational settings.

The methods which are recommended for structuring or achieving synthesis in SLR, however, are rather superficial from a PSMs perspective. For example, Rowley & Slack (2004) recommend conceptual mapping, defined as "a picture of the territory under study". The map represents "the concepts in that area and the relationship between them" stressing that "it is important to
recognise that there is no correct answer for a concept map – their purpose is to assist the researcher to develop their understanding". Tranfield et al. (2003) recommend approaches based on 'realist synthesis' or 'meta-synthesis' which both use conceptual modelling to develop interpretive models. Thomas (2003) offers an inductive analytical approach for analysing extensive and varied text to derive summary findings leading to a model or theory about the underlying structure of experiences or processes evident in the text. All these structuring methods have been developed to epistemologically justify the approach taken by researchers to create knowledge from unusual data sources. Although they deal essentially with problem structuring, they ignore the potential benefits of integrating PSMs within their methodological framework. For example, the complexity of these synthesis processes and their qualitative nature often precludes their description in transparent steps. This is where influence diagrams can make a contribution. Below we outline a case study where we used a process involving influence diagrams which helped researchers to make sense of

the interaction between the range of models proposed in the literature.

4.0 THE CASE STUDY

4.1 The context

The case company (hereby known as 'Mining') is a large mining company based in North Africa. A specificity of Mining is to compete in international markets, and therefore to be subject to international competitiveness standards, whilst operating in an emerging economy. A main challenge is that its local economic environment does not provide a reliable set of suppliers to which activities can be subcontracted. It was in this context that an action research project was initiated, with the objectives of identifying (a) what guidelines could be used to select activities to be outsourced, and (b) how to manage outsourcing whilst maintaining current performance levels. The aim of the literature review was to develop a model of outsourcing which would assist Mining in their decision making.

A simple narrative approach to the literature review was quickly halted after it became apparent that:

- A huge body of literature on the design of supply chain systems made it clear that not all relevant articles could be reviewed, yet a broad scope was necessary.
- In the exotic context of Mining, all decision models led to the same conclusion: do not outsource. This was precisely the conclusion that Mining had absolutely no interest in.
- The detailed recommendations of various models from the literature were often contradictory. For example, it is difficult to explain why Honda decided to invest in engines and power trains as core competencies whilst Chrysler decided to outsource these components (Hamel and Heene, 1994; Prahalad and Hamel, 1990).

If pursued, these problems may have caused the knowledge developed from the literature review to be either overly simplistic, or ridden with inconsistency. The team decided that an approach using influence diagrams would be used, for reasons to be discussed later.

4.2 The context of the literature review

To objectively assess the value of this paper it is important to clearly understand the context of the research. The project took place in 2002, so only books and papers published prior to 2002 could be considered. The university in which this project took place was created in 1995 in an emerging economy. Although it had a modern library and access to some electronic databases, literature published prior to 1995 was hard to source – although some was available. Thus, access to the latest knowledge was limited.

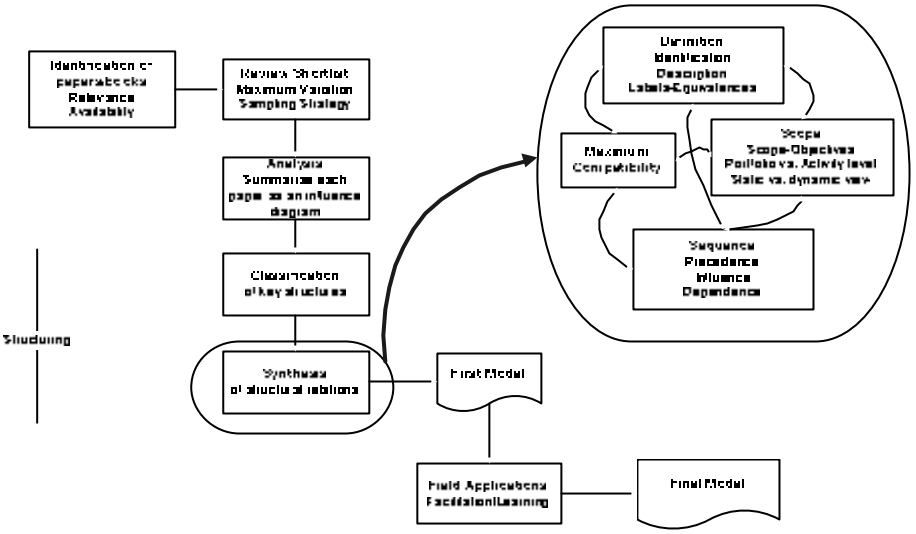
5.0 THE APPROACH USED IN MINING

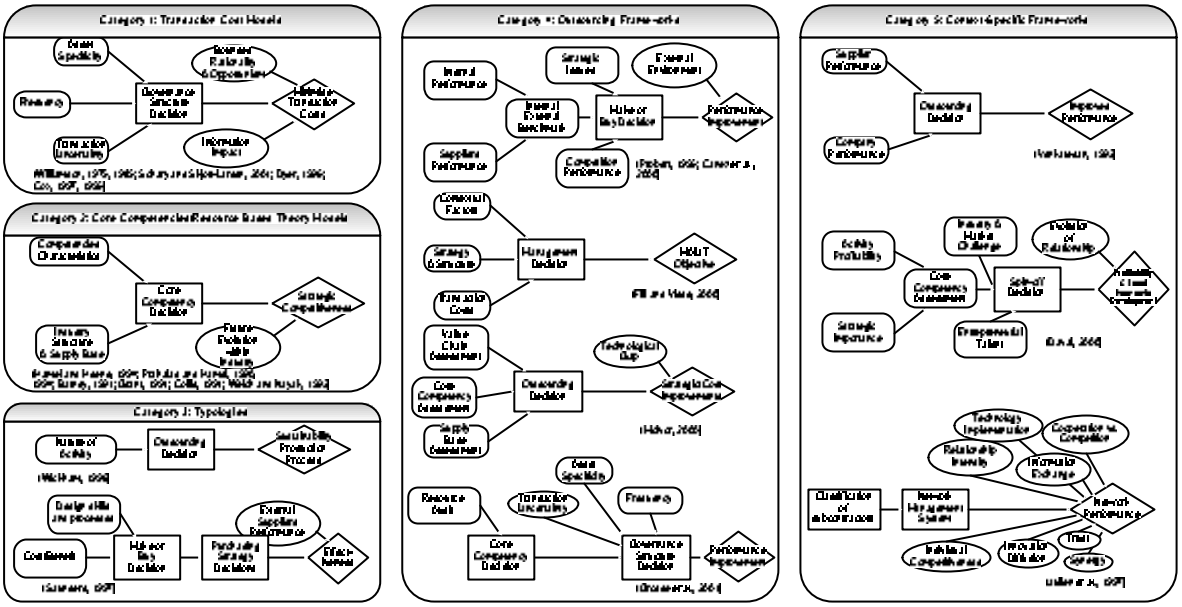
The approach used to develop the literature review is shown in Figure 1. Each step is discussed below to show how the project progressed from the literature review, to the development of a conceptual model, and to the utilisation of the conceptual model within Mining.

Stage 1: Identify key research fields and key paper/books

The first task was to agree the research fields relevant for this literature review. This followed a time during which the research team became familiar with Mining's business and competencies. The research team and representatives from Mining agreed that the core fields included: transaction cost economics; core competencies/capabilities; the resource based view of the firm; the accounting notion of a make or buy decision; and given spin-off management models.

Following an initial review of the literature, within these fields and within the restricted availability of literature, key references which addressed the challenge faced by Mining were identified by the research team. More literature was introduced throughout the project as it emerged.


Identification of papers/articles
Relevance
Availability
Review Shortlist
Maximum Variation
Sampling Strategy
Analysis
Summarize each paper as an influence diagram
Classification of key structures
Synthesis of structural relations
Structuring
Definition
Identification
Description
Labels-Equivalences
Maximum Compatibility
Scope
Scope-Objectives
Portfolio vs. Activity level
Static vs. dynamic view
Sequence
Precedence
Influence
Dependence
Final Model
Field Application
Facilitation/Learning
Final Model

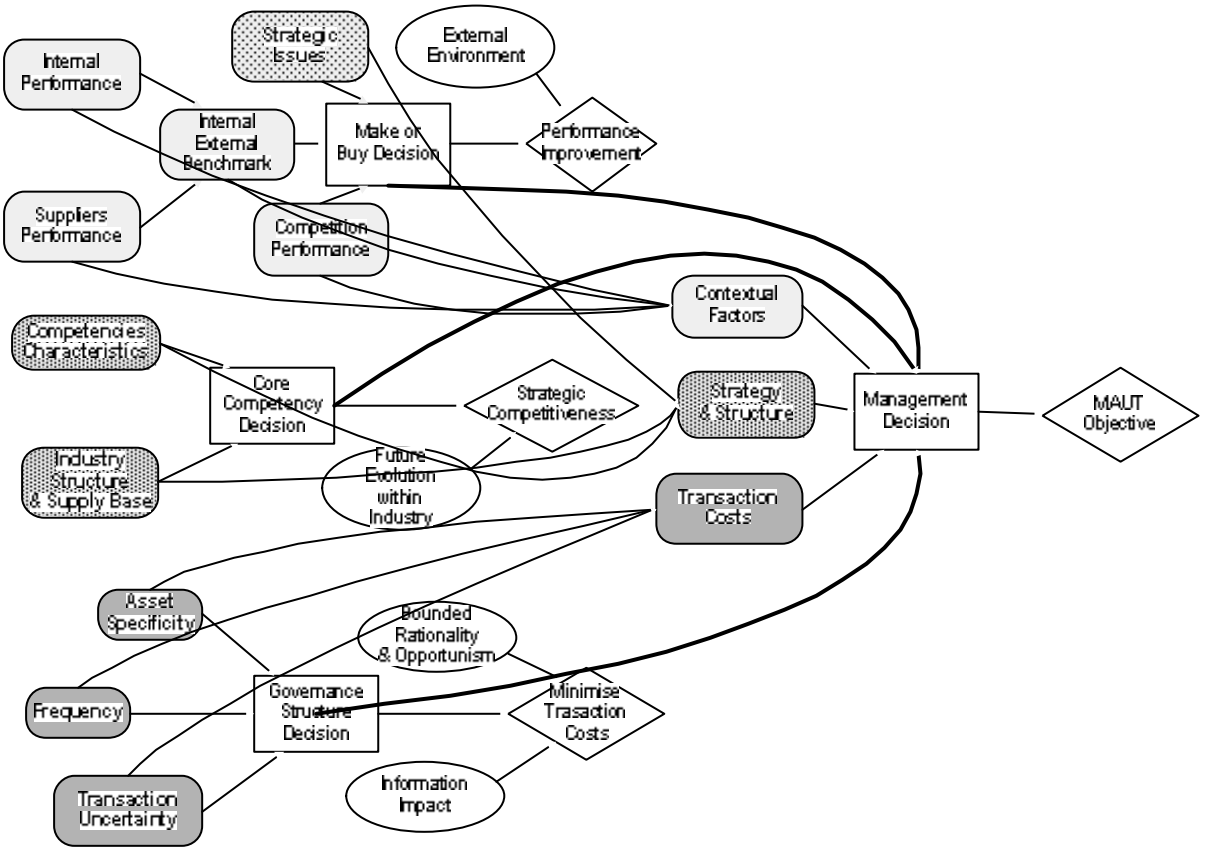

Category 1: Transaction Cost Models
Asset Specificity
Governance Structure Decision
Frequency
Transaction Uncertainty
Information Impact
Bounded Rationality & Opportunism
Minimize Transaction Costs
Category 2: Core Competencies/Resource Based Theory Models
Competencies Characteristics
Core Competency Decision
Inimitable Structure & Supply Base
Future Decision -able Industry
Strategic Competitiveness
Category 3: Typologies
Nature of Activity
Ownership Decision
Sensitivity, Proximity or Process
Design skills are processed
Core Competency
Make or Buy Decision
Purchasing Strategy Decision
External Supplier Performance
Effective Interest
Category 4: Ownership Framework
Internal Performance
Internal Process Benchmark
Supplier Performance
Strategic Issues
External Environment
Make or Buy Decision
Performance Improvement
Competitor Performance
Contextual Factors
Strategy Alternatives
Management Decision
Transaction Costs
MAUT Objective
Value Chain Assessment
Core Competency Assessment
Supply Base Assessment
Ownership Decision
Technological Gap
Strategic Core Improvement
Asset Specificity
Resource Audit
Transaction Uncertainty
Frequency
Core Competency Decision
Governance Structure Decision
Performance Improvement
Category 5: Context-Specific Frameworks
Supplier Performance
Ownership Decision
Company Performance
Improved Performance
Activity Profitability
Industry & Market Challenge
Evolution of Relationship
Core Competency Assessment
Spin-off Decision
Profitability & Asset Investment Development
Strategic Importance
Entrepreneurial Talent
Technology Implementation
Cooperation vs. Competition
Relationship Intensity
Information Exchange
Classification of Activities
Network Management System
Network Performance
Individual Competitiveness
Innovation Diffusion
Trust
Conflict

objectives cited in the literature. Too often, papers switched from one level to another without making the shift in scope explicit. ***Sequence*** involved understanding the interaction between different decisions and variables and their logical order in the process of decision making.

Determining sequence is dependent on the decisions made in the definition and scope activities. For example, expanding the scope of a decision may change its position in a chain of decisions. This dependency between the structuring activities explains why it is necessary to describe the structuring work as cyclical. Synthesising the individual influence diagrams was a process of discussion, reflection, trial and error, and incremental improvement. This was initiated at the research team level and pursued with small and large group meetings within Mining.

These three structuring activities (definition, scope, sequence) have in common that they re-define and clarify individual elements, or relationships between elements of the influence diagrams revealed by the literature review. The key challenge was to achieve ***maximum compatibility*** (from Figure 1) when synthesising the individual influence diagrams.

In an ideal case, new elements could be assembled nicely into a cohesive whole, through a "click-together" assembly process which does not require revisiting the definition, scope, and sequence activities. The result of this "click-together" assemblage is illustrated in Figure 3. Figure 3 shows how the decision model of Fill & Visse (2000) is an assemblage of Category 1 (transaction cost theory), Category 2 (core competency theory) and traditional accounting make or buy frameworks influence diagrams.



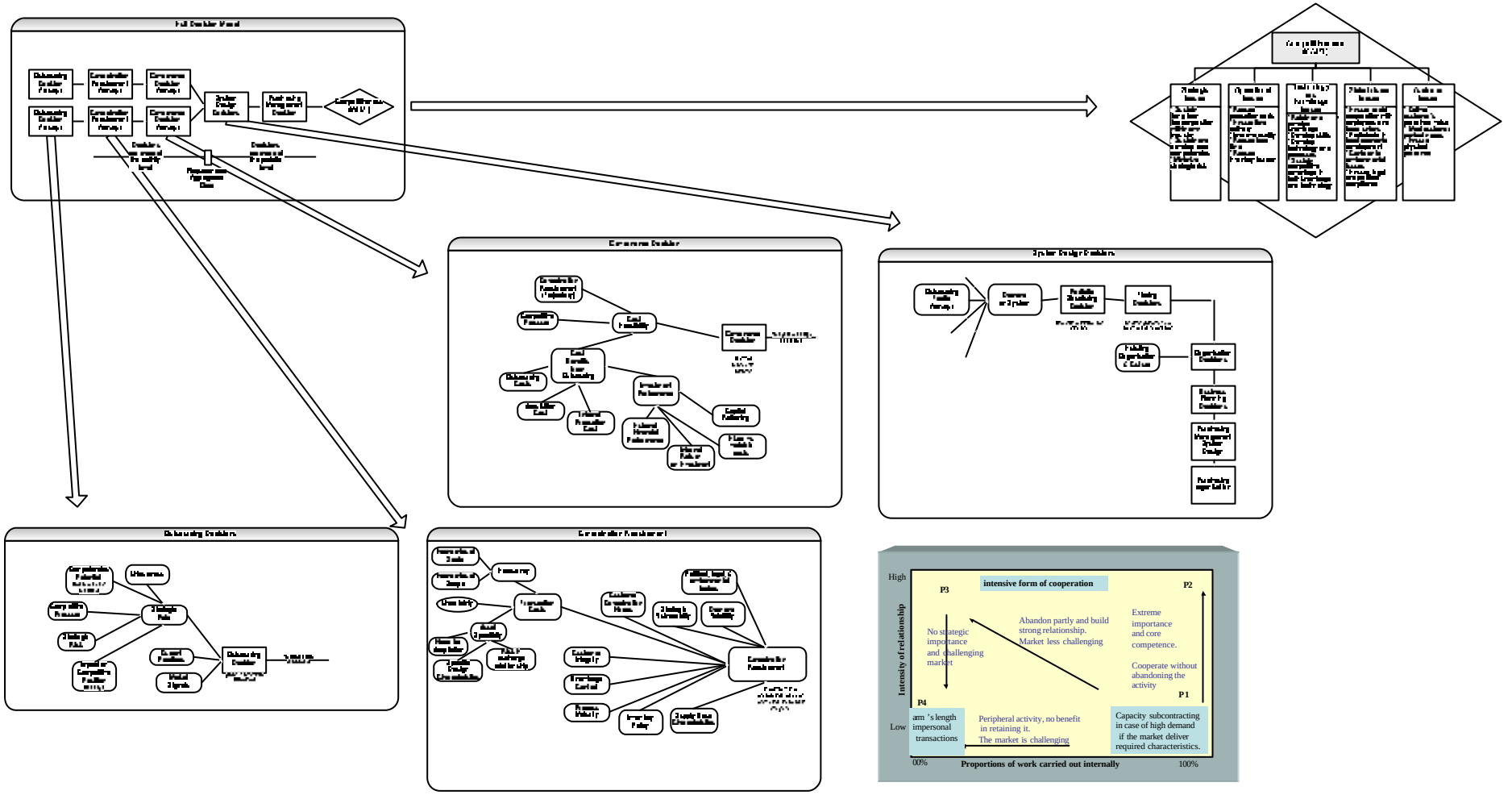


Figure 4. The decision model used in Mining

Figure 4 shows that final synthesized influence diagram used by Mining. We will now explain the final decision model: Designing and organising a supply chain management system involves a chain of decisions presented in the macro decision chain shown in the top left corner of Figure 4.

The ultimate decision objective of the model is to enhance competitiveness. The lozenge in the top right corner of Figure 4 presents the most general formulation of the various sub-objectives derived from the literature review. Other parts of Figure 4 provide more detail of the decision chain. The details of the decision and of Figure 4 are not critical to this paper. What are critical are the process through which this Figure was developed (as discussed above) and the way in which this model was used within Mining to support their decision making.

Stage 5. Validation in the field

Testing the robustness and appropriateness of the model in Figure 4 was done with Mining staff. A number of interviews with managers from across the organisation were conducted (both formally and informally). Formal interviews were semi-structured and transcribed. Interviewees were given a quick introduction to the use of influence diagrams and to the concept of structuring decisions. When significant adjustments to the model were offered by interviewees these were verified across Mining. In some cases this took the form of meetings with groups of managers where the objective was to test the appropriateness of the adjustment and explore further adjustments in the light of this.

The model was also tested using real business scenarios (e.g. equipment maintenance, drilling activity) with Mining during meetings of their managers.

The product of Stage 5 was the confidence that the model developed from the literature had been adapted to Mining's exotic context by those who would use the model to make decisions. Also, Mining staff understood the content of the models intimately and had been shown how to use the models to support their decision making. It was now for the models to be used by Mining to support their decisions for outsourcing.

6.0 REFLECTIONS …

6.1 … from the researchers

The process of structuring a literature review as we have outlined above requires researchers to view the activity as one that aims to produce cumulative knowledge. This requires either as a "vehicle for learning" perspective (Bruce, 1994) where literature is a springboard for the researcher to formulate a more elaborate, novel research direction or as a "research facilitator" perspective where literature informs the researcher at different points of the project and helps to re-conceptualize the research. With these perspectives, the researcher brings inquisitiveness and genuine interest to find out – not merely to go through the motions. However, some researchers view the literature review simply as a "search" for appropriate literature (Bruce, 1994), or the compilation of a "list" of findings, or even as a "survey" to support the research thesis but not to actively shape it. It is unlikely that these researchers would require a problem structuring approach as their needs are not advanced enough to appreciate the importance of uncovering the hidden, subtle messages/knowledge contained in the models, nor might they be inquisitive enough to go the extra step to construct the models thoroughly.

However, a significant problem exists for those aiming to present cumulative knowledge from literature reviews. That knowledge will have to withstand evaluation to ensure that the structure emerging from the literature review is justified on epistemological grounds. Below we propose a framework that researchers can use to assess their structured literature review. This framework stresses that traditional measures of the quality of a literature review (e.g. exhaustivity) are concerned with form rather than content (i.e. structure, or quality of synthesis).

- *Competence:* A literature review should competently describe the topic of investigation and legitimate research questions. Competency encapsulates comprehensiveness, currency, topicality, relevance, authority, and breadth. Furthermore, the review should include references which are in opposition, or form a paradox with the thesis. These secondary dimensions contribute to competency, but do not substitute it, i.e. competence can be achieved even if an important reference has been omitted but the concepts it contains are covered by other references in the review.
- *Congruence*: A literature review should present a conceptual framework legitimised by the reviewed sources. Congruence means that different research results from different disciplines reach conclusions which are relevant to a review, and justify the fact that the conceptual model is based on meta-evidence. Congruence, however, does not require absolute similarity of research objectives.
- *Consistency*: A consistent literature review means that apparent conflicts and paradoxes presented across papers/fields are fully accounted for. Conflicts

will not perfectly converge with the thesis, but they should remain *consistent* with it. For example, paradoxes may be resolved by: revealing definition problems e.g. language or meaning; clarifying the scope of a proposition e.g. temporal or spatial issues; creating new theory (Poole and Van de Ven, 1989). However, there are cases where conflicts cannot be eliminated: in this case a maximum compatibility approach is justified. A literature review is perhaps more productive if it seeks maximum compatibility instead of claiming originality by over-emphasizing differences of meaning.

- *Stability*: The discovery of new references should not affect the underlying structure of the conceptual framework. Additions should neatly insert themselves in the existing framework without breaking down its structure. An unstable literature review is one that needs rewriting, whereas a stable one will only require the insertion of one line of text. Stability is perhaps more commendable than exhaustiveness and currency, as it directly assesses the robustness of the structure derived from the review.

From a practical standpoint, the final model for Mining (Figure 4) has performed well against these four measures. Seeking *consistency* was the main driver behind the research, and thus it is not surprising that the model does well on that count. *Competence* was judged excellent by the client, but average by academics (presentations in academic conferences, and written comments from anonymous reviewers for supply chain management specialist journals). A standard criticism of academics is that the model is not based on an exhaustive literature review. This is hardly surprising given the limited access to sources at the time of the review. It is interesting however, that concerns of exhaustivity are a critical issue. Such comments illustrate the *congruence* between the model and additional literature. It also demonstrates that these additional literatures refine, rather than contradict, the existing model. This demonstrates the stability of the model and its robustness.

The differentiating factor of the model with these references is that role and requirements may evolve over time. This issue which was critical to Mining has never been commented upon by academics. Instead, feedback often concerns the generalisability of findings from a unique case study. The tension between competence versus exhaustivity, consistency and congruence versus originality, exhaustivity versus stability, and more generally content versus form and structure versus style raise fundamental questions regarding how literature reviews, and their outputs, have been customarily assessed in academia.

6.2 … from the organisation's managers

The objectives of the project were met in full and to the client's satisfaction. The final client report described how Mining could select activities to be outsourced, and the issues which they may need to resolve as they outsource operations. By way of evaluating the impact of the approach and the influence diagrams on decision making in Mining, we can offer initial reflections on how the models are used and opinions from the managers who use them.

The models are often still used within meetings when they are permanently, publicly displayed and used extensively to structure discussions. For example, when a manager attempts to introduce a stray concept, the meeting chairman can refer back to the model to show why this is a red-herring or why it should be discussed later under a different part of the process to outsource.

The model has also been used as a device through which discussion can happen. In the five year preceding the delivery of the model, Mining staff would often engage in circular and ill-informed arguments about core competencies, and the extent to which supply chain management was (ir)relevant in strengthening competencies. Often this issue would hi-jack meetings and threaten their abortion. Here the model was an extremely effective tool for moving the group beyond the issue. Skeptical staff were given space to share their view, but that they had to structure their reservations coherently in the language of structured decisions rather than as logically unsound opinions. This process helped to surface the logical inconsistencies within arguments or (less frequently) allow the group to explore legitimate concerns more fully. In most cases staff finally accepted the potential of supply chain management because they were persuaded by colleagues counter arguments which often relied on the content and structure of the model.

Mining is entirely composed of technicians and engineers and so influence diagrams present a logical and rigorous but abstract way of exchanging ideas which naturally appealed to these engineers. The implementation of the practice in other contexts may be more difficult.

7.0 CONCLUSIONS

Although PSMs support the structuring of knowledge in decision making activities, they have not been applied to facilitating the process of producing a literature review. A literature review can share many of the characteristics of PSMs e.g.: involving several

conflicting views; dealing with uncertainty; being a transitional process; being a learning process; demanding the synthesis of numerous, complex amounts of data which is often contradictory; needing to avoid researcher bias.

Although the development of novel procedures, like the systematic literature review process, have strengthened what has traditionally been the weak link of the research method process, structuring the content of literature reviews is a poorly documented subject. Here, PSMs can help. This paper has shown the application of influence diagrams to support the structuring of a problematic literature review.

In addition to employing this technique to structure literature reviews, there are several implications for future research. First, as discussed earlier, one limitation of influence diagrams is that they only adequately model decisions, and not all literature reviews deal with understanding managerial decisions. Other PSMs might be useful here by enabling researchers to structure literature discussing other phenomena. Second, the Mining case study is one where the client assists the model building process by providing expert advice from their context. This can be perceived to reduce the generalisability of the findings to other contexts. The question of what constitute evidence in a synthesis exercise, such as a literature review, is an under-researched area. Third, researchers might like to experiment with applying OR/MS models to unusual situations to discover more about the limitations of the approaches. In addition to contributing to evaluating the methods, this could also take the methods outside OR/MS and expand the population who might benefit from them. This is one way of growing the community and, thus, strengthening its sustainability. However, caution might be warranted as it might also bring abuse of the techniques, and inappropriate application.

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